A REVISION OF AUSTRALIAN GENERA OF ARCHAEOCYATHA

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SUMMARY

The paper gives a brief reconsideration of the systematics of Archaeocyatha and tables of their classification. For the Class Irregularia, a first attempt is made to distinguish genera by standard diagnostic characters. An alphabetic catalogue gives revised diagnoses of genera occurring in Australia and their placing in families, together with other relevant information. Three new species which are type species of new genera are described in an appendix.

INTRODUCTION

The aim of this paper is mainly to give the specialists on Archaeocyatha the new definition of every genus established on Australian material, either by the first authors T. G. Taylor, R., W. R. and J. Bedford, or by subsequent designation. In fact, original collections being acquired by different Museums, it is very difficult to have this work done; I am indebted to Professor M. F. Glaessner from the University of Adelaide, Dr. B. Daily, formerly at the South Australian Museum, Professor A. G. Fischer and Professor B. F. Howell from Princeton University, Dr. W. Ball from the British Museum (Natural History) who agreed to loan to me from the collections in their keeping, or for the last three, who gave me the opportunity of studying in their Department.

Besides the types of genera and species, there are very numerous undescribed fossils; recently Dr. B. Daily and Dr. M. R. Walter kindly sent me further new material. A complete revision will take me at least one more year. The results of these studies will be published as a monograph by the "Muséum d'Histoire Naturelle", Paris, not before 1972 or 1973.

This is the reason why, on the advice of Professor Lehman, Director of the Institute of Paleontology of Natural History Museum (Paris) and Professor Glaessner, University of Adelaide, I decided to write a catalogue of the Australian genera.

This paper gives for each genus: its type-species, and the place where it is kept,
—the original diagnosis by the author of the genus, or when there is no diagnosis for the genus, as it often occurs in Bedford's papers, the diagnosis of the type specimen, with the omission of indications which are relevant only on the specific level.
—the present diagnosis after restudying typical material.
—when necessary a discussion concerning the differences between original and present diagnosis or its affinities.
—the place of the genus in present classification.

Because of some considerations for the present edition, it was not possible to give an iconography of genera, Taylor's, Hill's and Debrenne's photographs filling this gap for the present. Only new genera are figured here; I hope that complete illustrations will appear in my next monograph.

Studies on outgrowths are not included; it would require a special work including Siberian and American specimens to state, as far as possible, their

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significance. *Somphocyathus*, *Ardrossacyathus*, *Exocyathus* and *Metaldetmorpha* are consequently not listed in this paper.

Before the enumeration in alphabetic order of the Australian genera, I shall recall some principles of systematics and give tables in which each genus can be easily placed.

CONSIDERATION OF THE SYSTEMATICS OF ARCHAEOCYATHA

Till now, Archaeocyatha are subdivided into two main groups, Regulares and Irregulares (Class Regularia Vologdin 1937 and class Irregularia Vologdin 1937) according to their first stages of development, taking the apex of *Dokidocyathus* as the type of the Regulares, and the apex of *Rhizacyathus*, *Alphacyathus* or *Dictocyathus* (according to different authors) as the type for the Irregulares.

Regular Archaeocyatha can be placed into a satisfactory classification established on simple rules (Zhuravleva 1960, Debrenne 1964). The changes in their classification come from new data, such as the discovery of new types of wall or the recognition of homologies in outer wall development (Rozanov 1966-1969). They mainly concern supra-family levels. The classification of Irregulares is not so clear, for several reasons. First of all, special studies on this group are not so numerous. Second, as they are of "irregular" appearance it is always difficult to establish the real spatial connections between the different elements of the intervallum structures. This requires more than 2 or 3 oriented sections per sample. The result is that they are often described as "vesicular or taenioid intervallum structures", "alveolar" or "scattered rods". Important genera as *Archaeocyathus* Billings, *Archaeosycon* Taylor (based on broken specimens which cannot be cut to show how they are built up) or *Dictyocyathus* (the type-specimen of which is lost and I was unable to find unquestionable topotypes in Sardinia, the Bornemann's description and figuration being too poor) are not well known. This lack in our knowledge stands in the way of establishing rules of classification for Irregulares.

Thirdly, these forms are probably more primitive than Regulares: they do not build highly specialized skeletal layers as complicated as the walls of Regulares, the main characteristic features of the adult are reached later during growth, and often concealed by persistence of secondary exothecal or endothecal lamellae, bulges, buds or encrusting forms in which the intervallum frame is more or less disturbed. Development of vesicular tissue is not constant but frequent. Synapticulae (or tangential links) occur in many cases; the more delicate the vertical frame and the more frequent the tangential links, the greater the irregular appearance of different sections.

The individual development is of little help for classification in such plastic forms, except for the distinction between Regulares and Irregulares. The individualization of the inner wall, the specialization of the outer wall and the radial arrangement of intervallum structures, the disappearance of secondary structures in the central cavity do not occur at the same level of growth amongst specimens from the same genus, or even from the same species.

Therefore, the primitive elements of apical parts (rods or booklets) represent potentially many kinds of adult structures in Irregulares, and here they are most probably initially dependent on the environment more than in the strongly built Regulares: thus they could not be used to define "recapitulated stages of evolution" and to state phylogenetic rules for systematics, as some previous authors have suggested.

My studies on Australian Irregulares and on some Moroccan and Sardinian ones, generally of oldest stratigraphical age, lead me to believe that there is

a strong tendency to build radial vertical structures which, finally produce adult forms very similar to Regulares. I have proposed to call these structures "pseudosepta" and to distinguish several types (Debrenne 1969a p. 332). These pseudosepta are not always in true vertical planes like the septa of Regulares. As I have stated before, when the skeletal material is thin, the connections are often distorted. On the other hand the pseudosepta are affected by wavy disposition at the level of synapticulae, the opposing crests corresponding to synapticulae.

When the skeleton becomes more important, these features disappear and the genus looks regular. Tabulae are present, either as sieves linked to a peculiar horizontal development of synapticulae, or as independent structures.

To distinguish in practice true Regular forms from Irregular ones with radial structures, when the apex is unknown (the great majority of the specimens are broken above the apex), the structure of the outer wall is the main feature. The porosity of pseudosepta is always important, even though this character is not yet well studied in Regulares. In Irregulares the pores have often various diameters; the pores occur along lines slanted obliquely upwards and outwards (with a more or less acute angle) from the inner wall, and then gently curved near the outer wall. Tabulae and inner wall have peculiar arrangements, but they have also some structures in common with Regulares: synapticulae and vesicular tissue, generally more frequent in Irregulares, are known in Regulares; so their presence is not sufficient to determine the class.

The problem of *Syringocnema*, which has radial honeycomb tubes is not clear. In some respects they resemble some "tube like-structures" built by the wavy sides of septa and flat synapticulae of *Pycnoidocyathus* type. In other ways, by the constant diameter of pores and the regular honeycomb construction, this genus resembles regular Archeocyatha. The holotype of the type species being poorly preserved, we need some more detailed studies to settle this question. This genus is temporarily placed as incertae sedis.

The classification of Regulares is based on the following scheme:

—primitive structures of internal space extending into the apex give the definition of ORDERS.

—elaboration of the different types of intervallum structures give the definition of the SUBORDERS.

—differentiation of the outer wall (which is reached before that of the inner wall) gives the definition of SUPERFAMILIES.

—at least differentiation of the inner wall gives the definition of the FAMILIES.

—the GENERA are established on subcategories of the porosity of walls (section of canals, of annuli, disposition of and correlation between pores, increase of the porous surface by vertical corrugations, etc.), and of porosity of intervallum structures.

As a working hypothesis, I suggest for Irregulares a table of classification based on the same pattern as above (Table A). As far as I know, this suggestion is not in opposition to their own growth pattern; but we must not forget that the differentiation of internal structure is established later than in Regulares and could be disturbed secondarily during growth by exothecal lamellae, budding bulges and so on. The main argument in favour of this viewpoint is that outer wall (a superfamily character) is the most characteristic feature separating Irregulares with regular intervallum structures from Regulares. It is difficult to define the main types of intervallum and walls until the whole class is exhaustively restudied; I for myself have not enough stratigraphical data (specially from upper part of the Lower Cambrian) to establish the limits of subdivisions with

certainty. Anyway, these new propositions are made to give rise to further discussion. This is the first attempt to unify the criteria of classification as between Regulares and Irregulares. Future studies will improve this method, if acceptable, or find another satisfactory scheme for the whole phylum.

TABLES OF CLASSIFICATION

Class REGULARIA

Order—MONOCYATHIDA—one wall.
Suborder MONOCYATHINA—internal space empty.
Family—simply porous wall— Monocyathidae
Monocyathus
Family—simple tumuli— Tumuliolynthidae
Tumuliolynthus (*M. irregularis* BEDFORD)
Order—AJACICYATHIDA—intervallum with radial partitions—
Suborder DOKIDOCYATHINA—intervallum with radial rods—
Superfamily DOKIDOCYTHACEA—outer wall simple—
Family—inner wall simple— Dokidocyathidae
Dokidocyathus
Acanthinocyathus
Suborder PUTAPACYATHINA—intervallum with only tabulae—
Superfamily APTOCYATHACEA—outer wall simple—
Family—inner wall simple— Aptocyathidae
Alphacyathus
Superfamily PUTAPACYATHACEA—outer wall with alternating pillars—
Family—inner wall with alternating pillars Putapacyathidae
Putapacyathus
Suborder AJACICYATHINA—intervallum with radial septa—
Superfamily AJACICYATHACEA—outer wall simple—
Family—inner wall simple, several pores per intersept— Ajacicyathidae
Ajacicyathus
Family—inner wall simple, one pore per intersept—Robustocyathidae
Robustocyathus
Stapicyathus
Family—inner wall simple several pores + protection structures— Tennericyathidae
Cadniacyathus
Family—inner wall with ethmophylloid canals (sensu lato)— ?Ethmophyllidae
Zonacyathus
Family—inner wall with one canal + annular plates— Ethmocyathidae
Ethmocyathus
Family—inner wall with annular shelves— Cyclocyathellidae
Thalamocyathus
Family—inner wall with annular shelves and canals — Bronchocyathidae
Cyathocricus
Superfamily ANNULOCYATHACEA—outer wall with simple tumuli—
Family—inner wall with one pore Tumulocyathidae
Dailycyathus (*Paranacyathus margarita*)

Superfamily SIGMOCYATHACEA—outer wall annulate—
Family—inner wall annulate— Sigmocyathidae
Sigmocyathus

Suborder NOCHOROICYATHINA—intervallum with radial septa and pectinate tabulae—
Superfamily NOCHOROICYATHACEA (outer wall simple)—
Family—inner wall with one canal + annular plates— Ethmopectinidae
Ethmopectinus (*lineatus* pars)
Family—inner wall with annular shelves and canals— Glaessericyathidae
Cricopectinus (*dentatum* pars)
Glaessnericyathus (*sigmoideus*)

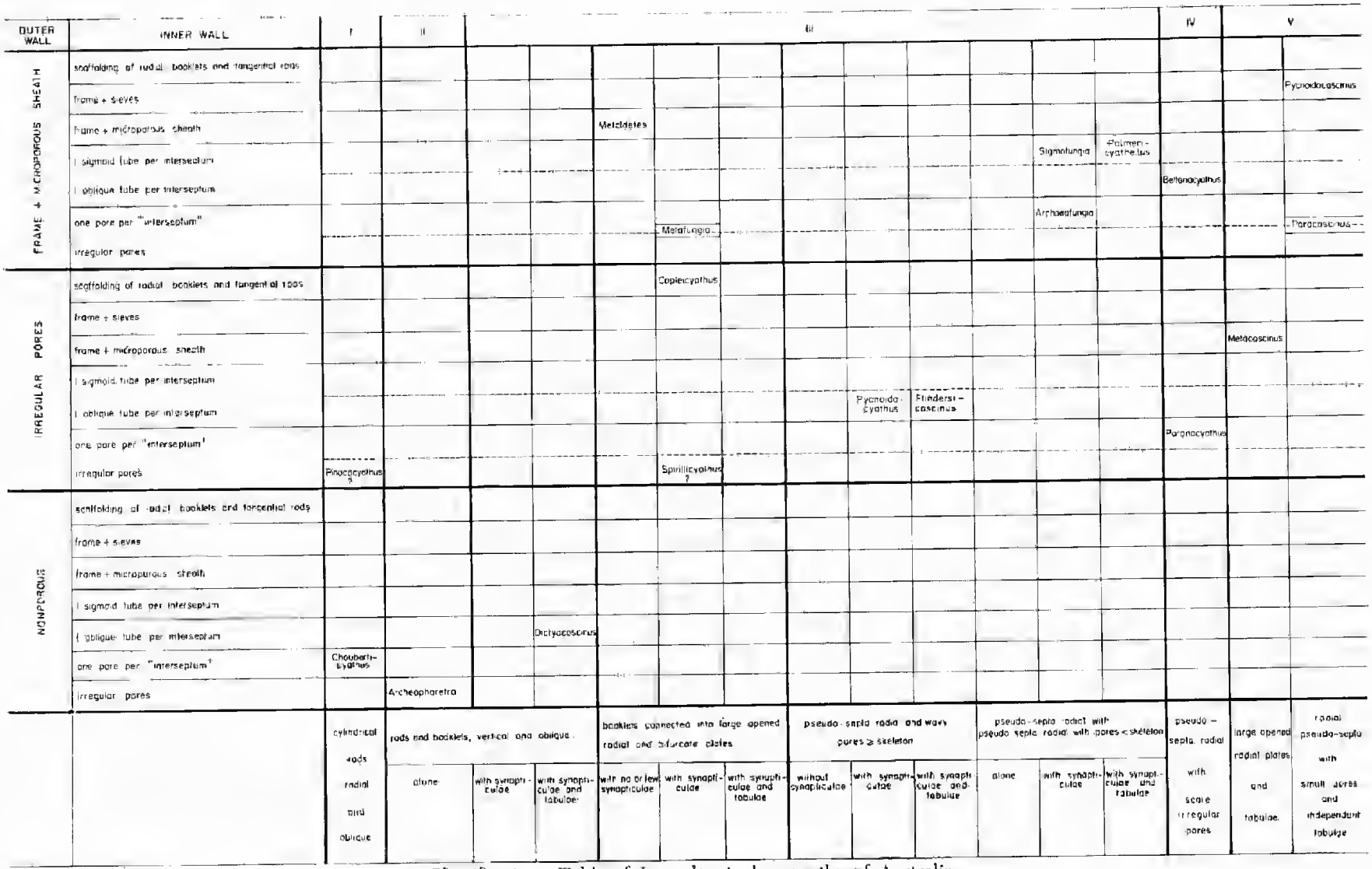
Suborder COSCINOCYATHINA—intervallum with radial septa and tabulae—
Superfamily ERISMACOSCINACEA—outer wall simple—
Family—inner wall simple— Erismacoscinidae
Erismacoscinus (*australis, bilateralis, textilis* etc.)
Rozanovicoscinus (*fonini*)— asperatus pars)
family—inner wall annulate— Stillicidocyathidae
Stillicidocyathus
Superfamily SIGMOCOSCINACEA—outer wall with protection structures—
Family—inner wall annulate— Sigmocoscinidae
Superfamily CALYPTOCOSCINACEA—outer wall: frame + microporous sheath—
Family—inner wall simple + spines— Polycoscinidae
Polycoscinus
Erugatocyathus
Superfamily ALATAUCYATHACEA—outer wall: tumuli—
Family—inner wall simple + spines— Tumulocoscinidae
Coscinoptycta
Superfamily ANAPTYCTOCYATHACEA—outer wall frame + sieves—
Family—inner wall simple— Anaptyctocyathidae
Anaptyctocyathus

Class IRREGULARIA

Based only on Australian, West European, and North African material. Must be completed by studies of material from higher stratigraphic levels.

Types of internal structures:
—one wall; central cavity filled
—two walls

Types of intervallum structures:
I—Cylindrical rods radial and oblique: CHOUBERTICYATHIDA
II—Rods and booklets vertical and oblique: ARCHAEOPHARETRIDA
III—Pseudo-septa (plates with wide pores to true radial plates with small, numerous pores the area of which is less than that of the skeleton), without or with synapticulae, or with synapticulae and pseudo-tabulae (synapticulae in horizontal planes + sieves) METALDETIDA
IV—Stout radial septa without synapticulae and tabulae: PARANACYATHIDA
V—Septa and independent tabulae: PARACOSCINIDA



Classification—Table of Irregular Archaeocyatha of Australia.

Types of outer wall:
—non-porous*
—aperture of intervallum without independent sheath
—irregular pores*
—one pore linked to the septa
—frame + microporous sheath*

* present in Australia

Types of inner wall:
—irregular pores
—one pore
—one canal straight or sigmoid
—frame + microporous sheath
—frame + sieves
—scaffolding of radial plates and flat tangential booklets.

As this is a first attempt at a new way of classification I do not give names to superfamilies until subsequent studies corroborate or invalidate the underlying hypothesis (see Table A).

Acanthinocyathus Bedford and Bedford 1936
(pro *Acanthocyathus* Bedford and Bedford, 1934, p. 4, fig. 20)

Type species. Acanthinocyathus apertus Bedford and Bedford (1934, p. 4, fig. 20). Lectotype: British Museum (Natural History) S 4166.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (R. and W. R. Bedford 1934, p. 4). The specimens agree with normal Archaeocyathinae in the possession of two walls; these are united by a very scanty framework of delicate radial rods. The inner wall is a very open simple polygonal net. The outer wall is built up, as it were, of a series of fused spicular elements enclosing large open spaces; spines or tubercules often project outwards beyond the general wall surface. The spitz, so far as known, has the same open net-like structure.

Present diagnosis (After restudying typical material, Debrenne 1969a, p. 306). Two-walled cups with radial, horizontal or sometimes oblique cylindrical rods. The inner wall consists of a large porous net, with a mesh of irregular size formed by skeletal threads of constant thickness. The outer wall has large pores in quincunx; the skeletal tissue occupies a smaller area than the pores and carries long spines that are directed upwards and outwards.

Discussion. R. and W. R. Bedford thought that the inner wall was a scaffolding of triradiate spicules. This suggestion is not borne out by observation: the outer wall is a porous sheet with the elongation of its horizontal skeletal parts into scales of an unusual size.

Systematic position. Family Dokidocyathidae Bedford and Bedford 1936.

Ajacicyathus Bedford and Bedford 1939

Type species by original designation: *Archaeocyathus ajax* Taylor (1920, p. 118, pl. 1a-e, j, k; pl. 3). Lectotype T. 1550a, University of Adelaide, chosen in an article in the press (Paleontologicheski Zhurn., Moscow).

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (R. and J. Bedford 1939, p. 73-74). ". . . Outer wall delicate with extremely fine pores distributed regularly. . . . Septa regularly arranged and

numerous, with pores rather remote and small. . . . Inner wall rather solid with regularly arranged pores, some being 'stirrup-pores', others not. . . ." Two-walled cups, solitary or colonial with regular radial septa.

Present diagnosis. Outer wall thin and regularly porous. Inner wall larger and stout, with regular pores; the inner wall and the septa are connected by one vertical row of stirrup-pores. Between two adjacent septa, one or more rows of pores are observed, arranged together with stirrup-pores in a quincunxial pattern. Radial septa straight and stout, with few, or no pores.

Discussion: The lack of porosity of septa is now considered as a generic characteristic; the result of this being the individualisation of each interseptal loculus. The presence of stirrup-pores at the inner wall is an important specialization. When septa are completely non-porous, exchanges between adjacent loculi are possible only at the level of stirrup-pores.

Systematic position. Family: Ajacicyathidae Bedford and Bedford 1939.

Alphacyathus Bedford and Bedford 1939

Type species by original designation: *Dictyocyathus annularis* R. and W. R. Bedford (1936, p. 13, fig. 55). Holotype P 942, South Australian Museum, Adelaide.

Original diagnosis (R. and W. R. Bedford 1936, p. 13, fig. 55). "Small tubular form, . . . Outer wall pores are obscured in the type specimen, but a second specimen . . . shows small irregular pores. . . . The short connecting rods in the intervallum tend to anastomose into horizontal rings. . . . The inner wall has small circular pores. . . ."

Emended diagnosis (R. and J. Bedford 1939, p. 72, fig. 169).

". . . there is a tendency of these (the rods) to be united by a single tangential row of synapticulae to form incomplete horizontal platforms a kind of forerunner of the tabulae of *Coscinocyathus*. This feature is specific and not essential to the genus. . . ."

Present diagnosis. Small cylindrical cups, with two simply porous walls. In the intervallum regularly spaced horizontal structures are present. They consist of cylindrical rods rising radially from the walls, but interrupted by tangential rods. There are no continuous bars from wall to wall, but tabulae-like structures with more or less quincuxial pores. One inner wall pore at each interradial space and at each horizontal level.

Discussion. The horizontal platforms which were regarded by R. and J. Bedford as only specific structure are now considered as generic characters and detailed examination shows that there are no true radial rods connected by annular synapticulae.

Systematic position. Family Aptocyathidae Konjushkov 1964.

Anaptyctocyathus Debrenne 1969

Type species Coscinocyathus cribripora R. and W. R. Bedford. Holotype: British Museum (Natural History) S. 4160.

Original diagnosis (Debrenne 1969a, p. 340). Cylindrical cup. Intervallum with straight radial septa, in which the hexagonal pores occupy a much larger surface in proportion to the skeletal tissue, and irregular flat tabulae that are finely perforated by very narrow pores. The inner wall is simple, with two rows of pores per interseptum, which are only weakly separated; in fact towards the upper part of the cup two neighbouring pores may coalesce. The pores of the outer wall are covered by knobs that are perforated by a central pore and a surrounding circle of six others.

Present diagnosis. The outer wall consists of a frame, with large pores, each of them being covered by a sieve, instead of low tumuli.

Discussion. A. Yu. Rozanov recently pointed out three types of "double wall". One of these corresponds to the structures of the outer wall of *cribripora*. Comparison with material from the Soviet Union makes it certain that there are no true tumuli but double walls with a simple frame covered by non-independent sieves.

Systematic position. Family Anaptyctocyathidae fam. nov.

Archaeofungia Taylor 1910

Type species by monotypy: *Archaeofungia ajax* Taylor (1910, p. 131, pl. 12, fig. 67, fig. 25). University of Adelaide No. T 1566.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (Taylor 1910, p. 131). "Cylindrical or conical forms without annulations, of small size with a comparatively narrow central cavity. They are characterised by a very strong development of synapticulae and appear to form a transition genus between *Archaeocyathus* and *Pycnoidocyathus*. . . ."

Present diagnosis. Small cylindrical or conical cups with smooth undulations. The apex is surrounded by exothecal lamellae and at the same level till a diameter of 10 mm. is reached, the central cavity is filled up by oblique porous tubes, which arise from the inner wall and become nearly vertical at the central part of the cup. The upper part of the central cavity is free of any skeletal elements; the inner wall has one horizontal canal per interseptum. The outer wall, at first concealed by exothecal lamellae is of double porosity, the first frame with irregular pores is covered by a microporous sheath. Septa radial, with few pores, connected by irregularly spaced synapticulae (Debrenne 1969b).

Discussion. The examination of typical material removes the doubts on this genus. It belongs to the Irregulares. Regular forms with synapticulae have to be put in the genus *Sibirecyathus* Vologdin, which is not a junior synonym of *Archaeofungia*.

Systematic position. Family Archaeofungiidae fam. nov.

Archaeopharetra Bedford and Bedford 1936

Type species by monotypy: *Archaeopharetra typica* R. and W. R. Bedford 1936 p. 17, fig. 75. Holotype P.969, South Australian Museum.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (R. and W. R. Bedford 1936, p. 17). "Small irregular tubular organisms, the space within the outer wall filled with a mass of irregular trabecular and dissepimental tissue without central cavity or defined inner wall. . . ."

Emended diagnosis (R. and J. Bedford 1937, p. 31). ". . . has centrally, in the upper part a kind of crude, irregular inner wall".

Present diagnosis. After restudying typical material: small cups with a non-porous outer wall horizontally striated by small annular corrugations. A true inner wall is defined for a diameter of 2 mm., but it could be concealed by the presence of skeletal bars and vesicular tissue in the central cavity; the intervallum is filled up by irregular skeletal elements, bar- or plate-like, mainly placed in vertical or oblique position, but more or less radial, vesicular tissue is also present. The apical part often consists of one wall and vesicular tissue only.

Discussion. The main new data is the presence of a true inner wall commencing at a diameter of 2 mm., and some tendency to a radial disposition of the elements.

Systematic position. Family Archaeopharetridae fam. nov.

Bedfordcyathus Vologdin 1957

Type species by monotypy: *Metacyathus irregularis* Bedford and Bedford (1934, p. 6, fig. 29). Holotype: British Museum (Natural History) S4189.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (after R. and W. R. Bedford 1934, p. 6).

Large irregular cone, with wavy outer wall the inner wall following a similar contour; wide cavity. . . . The outer wall has an underlying layer of fairly large irregular pores masked by a finer network. . . . Septa straight and delicate, easy to expose in transverse and tangential section, but not in radial section. No satisfactory trace of inner wall.

Emended diagnosis (after Debrenne 1969a, p. 360). The inner wall appears to be covered by an irregular microporous sheath which screens the simple pores.

Discussion (after Debrenne F. 1969a, p. 355). There is no appreciable difference from *Metacyathus* in the structure of the intervallum (apart from the abundance of vesicular tissue) or in that of the walls. Consequently *Bedfordcyathus* is considered as identical with *Metacyathus* which is a junior synonym of *Metaldetes*.

Beltanacyathus Bedford and Bedford 1936

Type species by original designation: *Beltanacyathus ionicus* Bedford and Bedford (1936, p. 23, fig. 96). Holotype no. 86716, Princeton University.

Lower Cambrian, Paint Mine, South Australia.

Original diagnosis (R. and J. Bedford 1936, p. 23). "Large conical cups with remote coarse-pored septa; the outer wall an irregular fine mesh carried by an underlying coarser mesh; the inner wall composed of exceedingly large regularly arranged canals leading upwards and inwards into the central cavity . . . coarse vertical fluting may be present."

Present diagnosis. Large conical cups, sometimes with vertical fluting. Intervallum with two kinds of radial partitions: (1) complete septa, running from outer to inner wall, strong, pierced by regular pores—the area of which is smaller than that formed by skeleton—and (2) vertical radial plates, in the middle of each interseptum, arising from the outer wall, not larger than ¼ of the space between the two walls, with no pores except one row against the outer wall. Outer wall double: the main frame consists of tubes of irregular polygonal openings, screened outwardly by a second microporous sheath. Inner wall with one pore tube per intersept, in horizontal and vertical lines. Tubes are long, set at a very acute angle with the wall. As far as known, radial septa are present down to the apex.

Systematic position. Family Beltanacyathidae fam. nov.

Cadniacyathus Bedford and Bedford 1937

Type species by original designation: *Cadniacyathus asperatus* Bedford and Bedford (1937, p. 36, fig. 152). Holotype 86616, Princeton University.

Lower Cambrian, Cadnia, Beltana, South Australia.

Original diagnosis (R. and J. Bedford 1937, p. 36). "Archaeocyathina with vertical flutes to the outer surface, the furrows corresponding to the positions of the septa; the inner wall with scale-like hooks projecting upwards and inwards into the central cavity. . . ."

Present diagnosis. Conical cups with vertical fluting. The outer wall has round pores regularly settled in quincunx. Septa straight, pierced by small remote pores. The inner wall consists of 2 or 3 rows of pores per intersept lined up horizontally. A horizontal plate arises from the lower edge of each pore, and joins

laterally the neighbouring one, so as to build a crude incomplete annular shelf which protected several pores. Jagged rim into the central cavity.

Discussion. This genus is very close to *Tennericyathus* ROZANOV 1969 which corresponds to the uncorrugated form of *Cadniacyathus*.

Systematic position. Family Tennericyathidae ROZANOV 1969.

Copleicyathus BEDFORD and BEDFORD 1937

Type species by original designation: *Copleicyathus confertus* BEDFORD and BEDFORD (1937, p. 29, fig. 116 A-D). Holotype 86741, Princeton University.

Lower Cambrian, Paint Mine, Beltana, South Australia.

Original diagnosis (R. and J. Bedford 1937, p. 29). ". . . A central cavity is present, at least in the upper part. Septa are numerous and are of 'wire-netting' character; although they are in places traceable right across the intervallum, they are very irregular and more often curve and anastomose with neighbouring septa. The inner wall is of very unusual type, being a thick, felted mass of curved anastomosing rods continuous outwardly with septal mesh. . . ."

Present diagnosis. Outer wall simple, rather thick, with pores less wide than skeleton. It is supported by some scarce spurs, coming out from septa. Septa are straight, the pores of which are irregular in form and size, grading from round to nearly rectangular. Synapticulae present, rather numerous near the inner wall. The inner wall is of quite complex structure. It looks like a second intervallum, with three times more crowded radial plates, connected by tangential ones. This felted mass opens directly into the central cavity, without any other specialized sheath.

Discussion. The septa are straight and radial and generally do not curve (as Bedford had stated). Their more or less irregular appearance depends on the orientation of sections, according as to whether they cross a skeletal part or pores, or cut tangential links. The intervallum and inner wall structures of the same pattern.

Systematic position. Family Copleicyathidae BEDFORD and BEDFORD 1937.

Coscinoptycta BROILI 1915
(pro *Coscinoptycha* TAYLOR 1910)

Type species by subsequent designation of Simon 1939, p. 26: *Coscinoptycha convoluta* TAYLOR (1910, p. 141, pl. XI, fig. 60). Holotype by original designation, University of Adelaide T. 1594.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (Taylor 1910, p. 141, pl. II, fig. 6, pl. VI, fig. 32, pl. XI, fig. 60-63, fig. 6-8).

"The shape is that of an extremely irregular and warped folded sheet, having very little resemblance to a regular cup, but better described as a warped bowl, of flabellate expansion. . . . It is of a large size judging from fragment preserved. . . . The intervallum is always quite small varying from one to two millimeters. The septa are regularly arranged, straight, and numerous. Tabulae are present at rather remote but regular intervals. The genus is based on the general shape of the organism. The septate lamina has occasionally large re-entrant foldings, so that the outer wall becomes concave. . . . The cup like form probably grades into that of the present genus. . . ."

Present diagnosis. Bowl-shaped cups with few perforate to imperforate septa and remote microporous tabulae. Vesicular tissue occurs when tersioid growths appear. Inner wall with 2 or 3 rows of pores protected by spines. Outer wall with one row of simple tumuli per intersept, perforated laterally.

Discussion. Material coming from the type locality enables us to state the position of inner (two rows of pores) and outer (one row of pores) walls, that corroborates Taylor's view.

Systematic position. Family Tumulocoscinidae ZHURAVLEVA 1960.

Cricopectinus gen. nov.

Type species: *C. dentulus* sp. nov. pro *Ethmophyllum dentatum* TAYLOR (pro parte) Taylor pl. XIV fig. 89. Holotype T 1589 B.

Diagnosis. Cup with radial septa, unperforated except for one vertical row of pores near the outer wall, and pectinate tabulae. Outer wall simple, with pores contracted outwardly; inner wall complex: horizontal lined canals serve as apertures for several loculi. They extend into central cavity by an annular shelf with deeply cogged free rims.

Systematic position. Glaessnericyathidae fam. nov.

Cyathocricus DEBRENNE 1969

Type species: *Archaeocyathus tracheodentatus* R. and W. R. BEDFORD 1934. Holotype: British Museum (Natural History) S 4754.

Original diagnosis (DEBRENNE 1969a, p. 318). Cup with a simply porous outer wall; straight, sparsely perforated radial septa and an annulate inner wall. Annuli consist of undulating, horizontal or slightly inclined plates, that are neither S- nor V-shaped; their axial rim is cogged.

Systematic position. Family Bronchocyathidae R. and J. BEDFORD 1936.

Dailycyathus gen. nov.

Type species by original designation: *Paranacyathus margarita* (BEDFORD and BEDFORD (pl. 1, figs. 4, 5). Holotype 87214, Princeton University.

Diagnosis. Large conical cups with regular radial septa and inner wall, but central cavity with skeletal structures arising from inner wall, near the apex. Adult stages could reach a large diameter with narrow intervallum, with vesicular tissue still present. Outer wall has one row of pores between 2 adjacent septa; each pore is covered by an hemispherical cap perforated laterally; inner wall has one row of stirrup-pores in front of each septa. Septa radial and imperforate except at the level of stirrup-pores.

Discussion. The presence of secondary skeletal structures in the central cavity is not a sufficient feature to place *Dailycyathus* amongst Irregulares; this kind of filling is known in many specimens of true Regulares. On the contrary, stirrup-pores and tumuli are typical features of Regulares.

Systematic position. Family Tumulocyathidae KRASNOPEEVA 1953.

This genus is dedicated to Dr. B. Daily, formerly South Australian Museum, now University of Adelaide.

Dictyocoscinus BEDFORD and BEDFORD 1936

Type species by monotypy: *Dictyocoscinus beltana* BEDFORD and BEDFORD. Holotype P 946, South Australian Museum.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (R. and W. R. Bedford 1936, p. 14, fig. 62).

Two walls connected by an open mesh similar to that of *Dictyocyathus*. At intervals a series of horizontal sieve-plates fill the interstices of the mesh, forming a tabular structure resembling that of *Coscinocyathus*.

Present diagnosis. Small cups only known. Outer wall non-porous. Inner wall with pore-tubes, alveoles, leading upwards and inwards into the central cavity; radial pseudo-septa, regularly made of plates, rather than rods, arranged in radial planes and connected by synapticulae. Some synapticulae are developed in horizontal planes. The holes defined by these synapticulae and the septa are screened by sieves with rather regular pores.

Systematic position. Family Dictyocoscinidae BEDFORD and BEDFORD 1936.

Dokidocyathus TAYLOR 1910

Type species by monotype: *Dokidocyathus simplicissimus* TAYLOR (1910, p. 146, pl. 13, pl. 77A, pl. 16, pl. 91-92). Holotype T 1589 AB, University of Adelaide.

Original diagnosis (after Taylor 1910, p. 146). ". . . Stout outer wall united to the yet stronger inner wall by remarkably few septa. The latter were particularly thick . . . , several longitudinal sections through the middle of the cups . . . (show) that intervallum was unoccupied by any connecting skeleton except a few struts which crossed it at remote intervals. . . ."

Present diagnosis. Long cones, with outer and inner walls simply porous, the intervallum between vertical rows of pores being strengthened by vertical ridges projecting into the intervallum from inner wall and outwards from outer wall. Radial partitions consist of flat plates settled in vertical plane, as septa with one large pore, the diameter of which is nearly equal to that of the intervallum.

Discussion. The species included in *Dokidocyathus* with cylindrical radial rods rather than flattened plates generally occur at lower stratigraphical levels (Tommotian stage) than *simplicissimus*. After comparison with the Siberian material and discussions with Russian specialists, I interpret the particular structure of the type species as indicating a tendency towards construction of true septa from rods.

Systematic position. Family Dokidocyathidae BEDFORD and BEDFORD 1936.

Erugatocyathus DEBRENNE 1969

Type species: *Coscinocyathus papillatus* R. and W. R. BEDFORD (1934, p. 3, fig. 12). Holotype: British Museum (Natural History) S 4153.

Original diagnosis (Debrenne 1969a, p. 334). Septa with remote round pores. Tabulae reticular. . . . The circular pores of the base of the coarsely porous outer wall are covered by a microporous sheath, in which each group of micropores consists of a central pore surrounded by 5 others. A skeletal tongue covers each simple pore of the inner wall.

Discussion. Till now, stellate or non-stellate inner walls are considered as sub-genus characters. *Erugatocyathus* is the unfolded form of *Tomocyathus* ROZANOV 1960, but Rozanov (personal communication) points out that stellate or fluted interseptum spaces correspond to an increase of porous surface and consequently could be of generic value.

Systematic position. Family Polycoscinidae DEBRENNE 1964.

Ethmocoscinus SIMON 1939

Type species by original designation: *Coscinocyathus papillipora* BEDFORD and BEDFORD (1934, p. 4, fig. 18). Holotype: British Museum (Natural History) S 4164.

Original diagnosis (R. and W. R. Bedford 1934, p. 4).

". . . Septa . . . with numerous fairly large pores. Tabulae remote . . . with numerous small pores. The outer wall has one or two rows of very characteristic

pores per intersept each pore entering a hollow hemispherical papilla projecting outwards from the wall, with an external perforation in the lower part of the papilla. The inner wall is also very characteristic; each intersept has a single row of thick-walled tubular pores leading upwards and inwards into the central cavity. . . ."

Present diagnosis (Debrenne 1969, p. 339). Cylindro-conical cups. Outer wall with simple sumuli, one per intersepaum. Inner wall with a single row of S-shaped pore tubes per interseptum. Septa have sparse simple pores; tabulae with polygonal, somewhat irregular pores.

Systematic position. Family Tumulocoscinidae Zhuravleva 1960.

Ethmocyathus Bedford and Bedford 1934

Type species by monotypy: *Ethmocyathus lineatus* Bedford and Bedford (1934, p. 2, fig. 8).

Lower Cambrian, Ajax Mine, Beltana, South Australia. Holotype: British Museum (Natural History), S 4149.

Original diagnosis (R. and W. R. Bedford, 1934, p. 2, fig. 8).

Ethmocyathus lineatus, the type and only species so far found, differs considerably from such genera as *Cyclocyathus* as it has three or four minute horizontal rings running across each pore of the inner wall.

Present diagnosis (Debrenne 1969a, p. 323). Cup with straight radial, sparsely porous septa. The outer wall has close, simple pores. The inner wall is composed of a thin sheet of hexagonal to rhombic pores, screened from the central cavity by thin, narrow horizontal annuli.

Systematic position. Family Ethmocyathidae Debrenne 1969.

Ethmopectinus gen. nov.

Type species: *E. walteri* sp. nov. pr *Ethmocyathus lineatus* Bedford and Bedford (pro parte). Holotype 86762, Princeton University.

Diagnosis. Conical cups with radial perforated septa and pectinate tabulae; outer wall gently fluted slit pores in quincunx, of small area outside as compared with skeletal pores, larger inside. Inner wall double: rhomb pore tubes, one per intersept screened by annular horizontal plates in the central cavity.

Systematic position. Family Ethmopectinidae fam. nov.

Flindersicoscinus gen. nov.

Type species by original designation, *Flindersicyathus tabulatus* Bedford and Bedford (1937, p. 29, fig. 111). Holotype 86666, Princeton University (pl. 11, fig. 3).

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (R. and J. Bedford 1937, p. 29).

". . . closely resembling *F. decipiens*. . . . The special feature . . . is the presence of upwardly convex 'growth tabulae'; these occur at irregular intervals. . . ."

Present diagnosis. Outer wall irregular. Inner wall with one pore per intersept. Pseudo-septa are connected by synapticulae—the pores between skeletal elements are large compared to skeleton. Pseudo-tabulae are synapticulae arranged in horizontal plane with secondary subdivisions and thickening, but no sieves.

Systematic position. Family? Pycnoidocyathidae Okulitch 1950.

Flindersicyathus BEDFORD and BEDFORD 1937

Type species by subsequent designation of Bedford and Bedford 1939, p. 78: *Flindersicyathus decipiens* BEDFORD and BEDFORD (1937, p. 28, fig. 109 a-b). Holotype 86670, Princeton University.

Original diagnosis (R. and J. Bedford, 1937, p. 28). ". . . Intervallar tissue of curved hexagonal-tubular lattices and by an inner wall with large pores leading upwards and inwards into the central cavity. . . ."

Present diagnosis (after Hill 1965, p. 123, Debrenne 1969a, p. 344 and restudying typical material).

The outer wall is simple, with an irregular mesh as pore-pattern. The inner wall has one row of short tubes per intertaenial and inter-synapticular space, leading upwards and inwards into the central cavity. Intervallum with pseudo-septa wavy in radial plane. The waves have angular crests and troughs, the side of which perforated by one row of regular round pores. The crests, the troughs and the pore-lines curve upwards and outwards from the inner wall. The crests of neighbouring septa are connected by synapticulae, the space between them being of the same size as the diameter of septal pores.

Discussion. The suggestion that *Pycnoidocyathus* could be the bulged form of *Flindersicyathus*, and for that reason should be considered as a sub-genus of *Flindersicyathus*, is made untenable by examination of typical material. In fact *Flindersicyathus* is junior synonym of *Pycnoidocyathus*.

Glaessnericyathus gen. nov.

Type species: *Bronchocyathus sigmoideus* BEDFORD and BEDFORD (1936). Holotype 86750, Princeton University (pl. 1, fig. 3).

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis. (R. and J. Bedford 1936, p. 25). Cups with straight non-porous septa and scarce pectinate tabulae. Outer wall with simple pores. Inner wall of annular type; the section of annuli is somewhat S-shaped, but with middle part oblique upwards and inwards, and α and β components nearly flat.

Discussion. As *Bronchocyathus* is an invalid name (Debrenne 1969a, p. 318), *aulax* TAYLOR having true *Coscinocyathus* tabulae, the forms with pectinate tabulae have to be placed in a new genus and a new family, which corresponds to Cyclocyathellidae Zhuravleva 1960 amongst Ajacicyathacea.

Systematic position. Family Glaessnericyathidae fam. nov. This genus is dedicated to Prof. M. F. Glaessner, University of Adelaide.

Metacoscinus BEDFORD and BEDFORD 1934

Type species by subsequent designation here: *Archaeocyathus retesepta* TAYLOR 1910. Holotype, University of Adelaide T1550 f.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (R. and W. R. Bedford 1934, p. 6). ". . . The upper part strongly resembles Taylor's *Archaeocyathus retesepta*, but we have not felt justified in claiming identity without Professor Taylor's sanction and direct comparison of the type specimen. The probable relationship is indicated by our specific name '*reteseptatus*' and, should the identity be admitted, the name would be *Metacoscinus retesepta* (TAYLOR). The genus may be defined as Metacyathidae with straight net like septa in the upper part, and with tabulae present."

Discussion. Having had the opportunity to compare *reteseptatus* Bedford with typical material of *retesepta* from Taylor's collection I can state that *reteseptatus* is a junior synonym of *retesepta*. Consequently, according to the International Code of Nomenclature art. 67 e, the type species of *Metacoscinus* is *retesepta* (Taylor).

Present diagnosis. Conical cups with sparse horizontal structures perforated by small circular pores, the skeletal part of which bearing tubercles. Radial septa built up by associated rods which have considerable opening between them, taller than wide. Outer wall with pores irregular outsides. Inner wall with 2 rows of polygonal pores separated by thin skeletal mesh.

Systematic position. Family Metacoscinidae Bedford and Bedford 1936.

Metacyathus Bedford and Bedford 1934

Type species by subsequent designation by Bedford and Bedford 1936, p. 20: *Metacyathus taylori* Bedford and Bedford (1934, p. 5, fig. 30). Holotype: British Museum (Natural History) S 4185-7 (one specimen).

Original diagnosis (R. and W. R. Bedford 1934, p. 5-6). ". . . the genus may be defined as Metacyathidae in which a combination of septal and trabecular masses extends to the upper part of the cup, with strong development of vesicular (dissepimental) tissue."

After revision of type material (Debrenne 1969a, p. 355), "the holotype of *M. taylori* shows that the structures of the intervallum are disturbed by the occurrence of exothecal lamellae, but that, at other levels, the plates continue from one wall to the other. The porosity of the outer wall depends on the presence or absence of the exotheca; the inner wall has one vertical row of pores in the lower part of the cup, but two or more at the upper part, with probably a second wall".

The conclusion was that *Metacyathus* is a junior synonym of *Metaldetes*.

Metafungia Bedford and Bedford 1934

Type species: *Metafungia reticulata* Bedford and Bedford by monotype. Holotype: British Museum (Natural History) S 4184.

Original diagnosis R. and W. R. Bedford (1934, p. 5). ". . . Metacyathidae having numerous regularly arranged synapticulae in the upper part of the cup."

Emended diagnosis (R. and W. R. Bedford 1936, p. 16). ". . . Archaeos having definite though irregular and highly porous septa and numerous regularly arrayed synapticulae; in the base the central cavity is absent, its place being taken by trabecular and dissepimental tissue; the outer surface is wavy but is not thrown into prominent flange.

Present diagnosis (Debrenne 1969a, p. 362). "Cup with central cavity that becomes free of skeletal tissue late in its development. The walls are double-porous. The intervallum is crossed by straight taeniae, which have their pores arranged in lines curving upwards and outwards; numerous synapticulae join the taeniae. The vesicular tissue is present at the base and in contact with tersioid outgrowths." The inner wall has one pore, generally divided into two parts by a thin skeletal vertical rod.

Systematic position. Family Metafungiidae Bedford and Bedford 1934.

Metaldetes Taylor 1910

Type species by monotypy: *Metaldetes cylindricus* Taylor (1910, p. 151, pl. 15, fig. 86). Holotype, University of Adelaide T 1592 A-E.

Lower Cambrian, Wilson, near Quorn. Wilkawillina Limestone. South Australia.

Original diagnosis (Taylor 1910, p. 151). "A cylindrical organism . . . , which is characterised by a striking change in structure during its growth. In the upper later portions it possesses a well-defined central cavity with a circular inner wall and regular septa, very coarsely perforate, which connect the inner and outer walls. A centimetre lower the septa are very irregular, though the inner wall preserves its definite outline. In the basal portions of the cup the inner wall is lost and the septa run right across the cup, apparently fusing at the centre with opposing septa. . . ."

Present diagnosis. Solitary or colonial cups. From an apical part entirely filled up by skeletal elements (bars, plates, vesicular tissue) irregularly scattered, inner wall and central cavity are defined late in growth development. At the same time, intervallum irregular structures change into pseudo-septa, radial (sometimes bifurcated) with coarse round pores of irregular size, connected by dissepimental horizontal vesicles. Outer wall has one frame with large pores, screened by a second microporous sheath, linked to the frame by rods (described by Taylor as tridents). Inner wall also of double structure (Debrenne 1969b).

Discussion. The suggestion (Debrenne 1969a, p. 355) that *Metacyathus* and *Bedfordcyathus* are junior synonyms of *Metaldetes* is confirmed by examination of type material.

Systematic position. Family Metacyathidae Bedford and Bedford 1934.

Monocyathus Bedford and Bedford 1934

Type species: *M. porosus* Bedford and Bedford 1934 selected by subsequent designation by Bedford and Bedford 1936. Holotype: British Museum (Natural History) S 4140.

Original diagnosis (after R. and W. R. Bedford 1934, p. 2, fig. 1). "A conical tube, often somewhat waved by gentle annular constrictions. . . . Wall thin, pierced by very uniform and regularly arranged pores; the pores . . . , are circular, and alternate as the rows are traced longitudinally but form a square pattern as the rows are traced diagonally; this is the most usual arrangement of pores in the inner wall of normal Archaeocyathinae. One specimen was noticed in which the rim at wide end is folded inwards to a depth of a little over 1 mm. and about the same distance inwards from the wall; this suggests that the wall may correspond to the outer wall of Archaeocyathinae. . . ."

Present diagnosis (Debrenne 1969a, p. 302). Small conical cups with a simple porous single wall and the vertical rows of pores in quincunx pattern.

Discussion. Okulitch (1950) Debrenne (1964) and Hill (1965) consider *Archaeolynthus* Taylor 1910 as an invalid name, as the type specimen was not designated by the author, and the reference material was destroyed by serial sectioning. The rim described by Bedford is not preserved in their various collections but Zhuravleva (personal communication) has discovered this feature in one specimen coming from a reference collection from Ajax Mine and interpreted it as the beginning of a "pelta" which could close up adult cups.

Systematic position. Family Monocyathidae Bedford and Bedford 1934.

Palmericyathellus gen. nov.

Type species by original designation here *Sigmofungia tabularis* Bedford and Bedford (1937, p. 29, fig. 115). Holotype 86746, Princeton University U.S.A. (Pl. 11, fig. 2).

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Diagnosis. Archaeocyatha with septa, synapticulae and tabulae. Outer wall with irregular polygonal pores, several per intersept. Inner wall with curved and bended canals, S-shaped, the aperture more or less hexagonal. Septa straight, pierced by small pores. The lines of pores and synapticulae are slightly curved from inner to outer wall. Tabulae frequent but irregularly spaced. They consist of microporous sieves developed between septa and special synapticulae arranged in horizontal planes, instead of along quincunxial lines as all the others.

Systematic position. Family Sigmofungiidae Bedford and Bedford 1936. This genus is dedicated to Prof. A. P. Palmer, State University of New York at Stony Brook.

Paracoscinus Bedford and Bedford 1936

Type species by original designation: *Paracoscinus mirabile* Bedford and Bedford (1936, p. 18, fig. 85-86). Holotype P 988, South Australian Museum, Adelaide.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (R. and W. R. Bedford, p. 18, fig. 85-86): ". . . The genus may be tentatively defined as having clearly defined septa and closely set curved tabulae, growing from an irregular base; the outer wall consisting of a finely porous layer supported by an irregular trabecular mesh. . . ."

Present diagnosis. Conical cup, the apex of which has an unperforate outer wall, radial septa and central cavity with alveoles. Adult stages with septa and close-set tabulae; pores in vertical and horizontal lines in septa, quincunxial in tabulae. Septa radial, thickened at their inner part. Tabulae nearly flat at the inner wall, arched outwardly. Outer wall with a frame of coarse rectangular to polygonal pores, covered by microporous sheath. Inner wall with vertical ridges corresponding to septa and 2 rows of square pores per intersept.

Systematic position. Family Paracoscinidae fam. nov.

Paranacyathus Bedford and Bedford 1937

(for *Paracyathus* Bedford and Bedford 1936 on Edwards and Haime 1848)

Type species by monotypy: *Paracyathus parvus* Bedford and Bedford (1936, p. 17, fig. 76). Holotype P 992, South Australian Museum, Adelaide.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (R. and W. R. Bedford 1936, p. 17, fig. 76). "Small conical forms in which the base is filled with irregular trabecular tissue without inner wall or septa, the outer wall having small irregular pores; within a short distance of the base clearly defined radial septa, inner wall and central cavity appear, and the small irregular outer wall pores are replaced by large and regular pores."

Present diagnosis. Conical cups with two walls, radial stout septa and generally vesicular tissue in the intersept. They developed from a base which consists of radial plates near the outer wall, ending and anastomosing in the central part of the internal space, surrounded by non-porous or irregularly porous outer wall. Inner wall and central cavity appear very soon. The outer wall has 2 rows of irregular pores per intersept, which may coalesce to form a rectangular one, or they may be protected by secondary thickening of their skeletal borders. One row of simple pores per intersept at the inner wall, regular and in quincunx. Septa radial, stout, with pores of less area than skeleton, irregular in size and arrangement. Vesicular tissue generally present.

Systematic position. Family Paranacyathidae fam. nov.

Pinacocyathus Bedford and Bedford 1934

Type species by monotypy: *Pinacocyathus spicularis* Bedford and Bedford (1934, p. 4). Holotype: British Museum (Natural History) S 4149.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (after R. and W. R. Bedford 1934, p. 4, fig. 21). "Conical tubes. . . . The outer wall consists of an open network. The principal members are a series . . . of vertical rods evenly spaced around the circumference of the wall; these rods, whilst for the most part lying at the periphery, dip occasionally a short distance inwards, they are united by short cross members which more frequently lie horizontally but may be inclined; in grinding away the surrounding matrix it was noticed that a few very short branch rods projected outwards from the wall. The inner wall cannot be fully seen . . . apparently it consists of an open network. . . ."

Present diagnosis (Debrenne 1969a, p. 342). "Two-walled cups with intervallar rods. The outer wall is formed by a scaffolding of vertical pillars connected by horizontal or slightly oblique rods. The inner wall is probably a regular net. Oblique or radial horizontal rods in the intervallum."

Discussion. This loosely-spaced framework is unknown in any other Archaeocyatha. Intervallum structures resemble those of *Choubertieyathus* Debrenne, but the walls are different.

Systematic position. Doubtfully in Family Dictyocyathidae Taylor 1910.

Polycoscinus Bedford and Bedford 1937

Type species by original designation: *Polycoscinus contortus* Bedford and Bedford (1937, p. 37, fig. 157). Holotype by monotypy 87217, Princeton University.

Lower Cambrian, Paint Mine, Beltana, South Australia.

Original diagnosis (R. and J. Bedford 1937, p. 37). "The genus is formed for the reception of two meandering, branching *Coscinocyathus* like forms from the 'Paint Mine'. . . ."

Present diagnosis. Colonial forms with porous septa and rather remote porous tabulae. The outer wall has vertical and horizontal fluting (independent from tabulae). It is of double-porous structure: coarse frame pores, covered outwards by thin microporous sheath. Septa have distant vertical rows of pores. Flat tabulae, the pores of which being the same diameter as those of septa but closed. Inner wall with vertical ridges towards the intervallum and cupules at the lower part of cup towards central cavity.

Discussion. The second species *complexus*, which has the same branching way of growth has simple walls. It belongs to *Pluralicoscinus* Debrenne 1963.

Systematic position. Family Polycoscinidae Debrenne 1964.

Putapacyathus Bedford and Bedford 1936

Type species by original designation: *Putapacyathus regularis* Bedford and Bedford (1936). Holotype 86699, Princeton University.

Lower Cambrian, Putapa Gap, South Australia.

Original diagnosis (after R. and J. Bedford 1936, p. 24). ". . . The outer wall has on its inner surface regular vertical ridges, . . . these are crossed by narrower bars . . . and each oblong space so formed is again divided by vertical partition so as to give an external surface regularly and quadrately porous. The inner wall . . . has a series of vertical ridges in two series, which alternately project into the intervallum and the central cavity. . . . Each ridge has a vertical series of 'stirrup-pores', so arranged that opposite each external ridge is an internal row of pores,

whilst all pores communicate with tangential perforations in the centre line of the wall, thus giving a clear though indirect communication between central cavity and intervallum. Regularly arranged, nearly horizontal tabulae . . . with numerous somewhat irregular pores. No septa or other structures representing septa are present. . . ."

Present diagnosis. Cup with no septa in the intervallum but only horizontal tabulae with rather regular pores; the two walls are built to the same pattern, the outer wall being thinner and more close-set. Each wall consists of a double cone of pillars in alternating positions so that opposite each pillar is an interspace. Their cross section is triangular, the apices of the internal pillars pointing towards the intervallum and those of the external ones towards the exterior. The bases of the triangles are in the middle portion of the cross section of the wall. The two circles of pillars are connected by regularly spaced horizontal rods.

Systematic position. Family Putapacyathidae Bedford and Bedford 1936.

Pycnoidocoscinus Bedford and Bedford 1936

Type species by original designation: *P. pycnoideum* Bedford and Bedford (1936, p. 19, fig. 87). Holotype P.990, South Australian Museum Adelaide.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis R. and W. R. Bedford (1936, p. 18, fig. 87). "Forms with numerous arched tabulae of unusual type; the outer wall has a finely porous layer supported by a trabecular mesh, and is thrown into large and prominent corrugation resembling those of *Pycnoidocyathus*. . . ."

Present diagnosis. With the exception of septa, the basic structures have two kinds of pores. Those of the outer wall are bounded by septa and more or less horizontal bars, and subdivided by rods which are parallel or oblique with regard to septa; they are screened outwardly by a microporous sheath. The inner wall has one rectangular pore per intersept with vertical ridges at each septum, and aligned (the tabulae lean against some of these horizontal bars). The pores may be subdivided by crude septa which are limited to the non-porous part and sometimes also by irregular oblique rods. Micropores may develop between these frames but not as an independent sheath. Septa radial with outer and inner part thickened and non-porous; while the middle part is thin and with numerous regular small pores. Tabulae strongly arched in their inner part, and gently sloping towards the outer wall. Pores are reticular as in *Retecoscinus* and with additional skeletal partitions parallel to septa.

Systematic position. Family Pycnoidocoscinidae fam. nov.

Pycnoidocyathus Taylor 1910

Type species by subsequent designation (Bedford and Bedford 1939, p. 78): *Pycnoidocyathus synapticulosus* Taylor (1910, p. 132, pl. 12, fig. 69). Holotype: University of Adelaide T 1587 B-C.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis Taylor (1910, p. 131). "A large conical tube, with a central cavity . . . . The outer wall is bulged into a series of annulations so that the outer diameter reaches 80 mm. and contracts to 50 mm. at regular intervals. This gives the organism the appearance of a stout tube strengthened by flanges. The inner wall is not influenced by the annulations. The septa are rather wavy and tend to anastomose in the peripheral portion. They are usually strengthened by very definite synapticulae, resembling those in many corals. . . ."

Present diagnosis. Outer wall simply a porous mesh. Inner wall with one large pore per intersept, as a short oblique tube, leading upwards and inwards into the

central cavity. Intervallum filled up by radial pseudo-septa, more or less wavy in radial plane, connected by synapticulae which define lines curving upwards and outwards from the inner wall; their curve turn nearly horizontally into flanges where present.

Discussion. There is no fundamental difference of structure between *Flindersicyathus* and *Pycnoidocyathus*. The revision of material coming from the type locality yields any number of intermediate forms between gently annulated forms and strongly bulged ones, and between intervallum structures with angulate crests and troughs, and more flat pseudo-septa. The differences observed are related to the size of the animal.

Systematic position. Family Pycnoidocyathidae Okulitch 1950.

Rhizacyathus Bedford and Bedford 1939

Type species by monotypy: *Protopharetra radix* R. and J. Bedford (1937, p. 28, fig. 107 A.B. 86619, Princeton University.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (R. and J. Bedford, p. 28). ". . . The outer wall is thick and clearly defined, but pores cannot be made out. . . . The interior is occupied by an anastomosing mass of bars. The bars are circular in section, but flattened, with rounded corners; their direction is sloping, but they approach a longitudinal rather than a transverse orientation.

Emended diagnosis (R. and J. Bedford 1939, p. 69). ". . . This has the structure neither of a regular Archaeo spitz nor of a transversely partitioned Metacyathine spitz. . . . The form may perhaps be regarded as one modified from *Monocyathus*."

Discussion after revision. The small conical forms called *Rhizacyathus* may be part of "tersioid" outgrowths. The longitudinal orientation of bars and their connections are very similar to those of "*Tersia*". *Rhizacyathus radix* is not an independent form of "*Archaeocyathus*" and has to be considered as invalid.

Other forms called "*Rhizacyathus*" by the Bedfords are *Archaeopharetra*, with vertical plates and inner wall.

Rozanovicoscinus gen. nov.

Type species: *R. fonini* sp. nov. pro *Cadniacyathus asperatus* Bedford and Bedford (pro parte) 86614, Princeton University.

Diagnosis. Cylindrical cups with vertical fluting the furrows corresponding to the septa. Septa and tabulae with round quincunxial pores of the same type. Tabulae flat, frequent, but irregularly spaced. Outer wall with round regularly spaced pores, in quincunx. Inner wall with short honeycomb tubes two or three per intersept.

Systematic position. Family Erismacoscinidae Debrenne 1964. This genus is dedicated to Dr. A. Yu. Rozanov (Geological Institute Academy of Science of the U.S.S.R., Moscow).

Sigmocoscinus Bedford and Bedford 1936

Type species by original designation: *Sigmocoscinus sigma* Bedford and Bedford (1936, p. 24, fig. 98). Holotype 86686, Princeton University.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (R. and J. Bedford 1936, p. 24, fig. 98). "The genus may be defined as cups with regular straight septa, tabulae of the normal *Coscinocyathus* type and continuous annular sigmoid plates inside the inner wall. . . ."

Present diagnosis. The intervallum consists of rectangular loculi built by normally porous septa and tabulae. The outer wall has several rows of pores per intersept in horizontal lines. The lower edges of pores project outwardly as peaks which could be fused laterally, forming somewhat annular scales. Inner wall of true annular sigmoidal pattern.

Discussion. The structure of the outer wall differs from that of the one of *Coscinocyathus didymoteichus*: several pores per intersept partially underlined by secondary element arising from the outer edge of pores.

Systematic position. Family Sigmocoscinidae Bedford and Bedford 1939.

Sigmocyathus Bedford and Bedford 1936
(*Hemistillicidocyathus* Ting 1937)

Type species by original designation: *Coscinocyathus didymoteichus* Taylor (1910, p. 140). Holotype, University of Adelaide T 1606 B-D (one specimen).

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (R. and J. Bedford 1936, p. 23). ". . . Large turbinate cups with numerous straight septa, without synapticulae or tabulae, the inner wall, or both wall, possess continuous annular sigmoidally-curved plates; growth is from an irregular base of trabecular and vesicular tissue which fills the central cavity and obliterates the septa. . . ."

Present diagnosis. Conical cups; numerous straight septa, with few widely spaced or no pores. No tabulae. Inner wall and outer wall with sigmoid annular plates, the middle part of the S being nearly horizontal, and the element covering almost entirely the apertures between two adjacent septa. The annuli of the outer wall are gently wavy horizontally, narrower and more crowded than those of inner wall.

Discussion. There is no proof that these forms grow a *Metacyathus*-like apex, the only specimen (230 A in Princeton collection) on which the Bedfords built their hypothesis is not connected with an adult stage of *C. didymoteichus* and does not present characters which could be interpreted as *didymoteichus*.

Systematic position. Family Sigmocyathidae Zhuravleva 1960.

Sigmofungia Bedford and Bedford 1936

Type species by monotypy: *Sigmofungia flindersi* Bedford and Bedford. Holotype P.963, South Australian Museum.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (R. and W. R. Bedford 1936, p. 16, fig. 82). "Archaeos having clearly defined radial septa which may be more or less irregular, with numerous synapticulae; the inner wall pores are in vertical rows, each pore being separated from those above and below it by a sigmoidally curved plate. . . ."

Present diagnosis. Straight and stout radial septa perforated by small regular round pores. Numerous synapticulae, specially in the outer $\frac{2}{3}$ part of intervallum. Outer wall with regular alveoles, restricted outwardly by processes rising from the boundaries of pores. Inner wall with one pore tube per intersept, which becomes sigmoid into the central cavity; they are settled in quincunx.

Discussion. The holotype has a central cavity secondarily filled by well developed vesicular tissue and skeletal plates connected to the inner wall. The skeletal plates become thinner and are resolved into thin connected bars during the development of the cups. Vesicular tissue still present. This feature is known only in one specimen, the other being free of endothecal tissue.

Systematic position. Family Sigmofungiidae Bedford and Bedford 1936.

Spirillicyathus R. and J. Bedford 1937

Type species by original designation: *Spirillicyathus tenuis* Bedford and Bedford (1937, p. 30, fig. 118). Holotype 86752, Princeton University.

Lower Cambrian, Paint Mine, South Australia.

Original diagnosis (R. and J. Bedford 1937, p. 30). ". . . The outer wall has irregular pores, formed by anastomosis of the underlying septal elements. The septa are built of a series of radial and longitudinal rods and are connected by tangential rods or 'synapticulae'. As seen in transverse section, the septa often run fairly straight from inner to outer wall, but they also often bifurcate and anastomose particularly near the outer wall. The inner wall is a definite layer with small circular pores, about two rows to the intersept. As far as we know the form grows from a spitz having essentially the same character."

Emended diagnosis (R. and J. Bedford 1939, p. 73). "These small forms which appear to grow from a spitz of *Alphacyathus* type present features intermediate between *Dictyocyathus* and the regular septate forms, having partial and rudimentary septa; the outer wall is more irregular than is usual in members of this order.

Present diagnosis. Microporous outer wall covering spurs rising from the outer part of septa. Septa rather clearly defined, generally radial, but also branching. The synapticulae are piled up in each interseptum. Simple inner wall with one or two rows of pores per intersept.

Discussion. The intervallum is filled up by septa and synapticulae rather than by anastomosing rods, but the lack of material and the smallness of holotype do not permit to point out clearly the true structure of this genus. As far as we know, young stages still have radial structures.

Systematic position. Family (doubtfully) Metacyathidae.

Stapicyathus Debrenne 1964

Type species: Archaeocyathus stapipora Taylor (1910, p. 118) by original designation of Debrenne (1964, p. 127). Holotype T. 1591, University of Adelaide, South Australia.

Original diagnosis (after Taylor 1910, pl. VII, fig. 37-38, Fig. 14). "Shape a conical beaker more or less elongated; occasionally bulged inward on each side giving an hour-glass cross section. . . . Outer wall somewhat thinner than the inner wall and perforated by numerous regular pores. . . . Septa regular and numerous. . . . A very characteristic feature is that the only pores visible are a single series of large openings where the septa join the inner wall . . . (stirrup-pores). Inner wall is somewhat thick, with one row of large pores along each inner septal edge as already described. . . . No pores in the intervals between septa."

Present diagnosis. Conical cups with outer wall thin and regularly porous. Inner wall thicker, with only one row of stirrup-pores in front of each septa. No other pores between them. Septa completely non-porous except the vertical row of pores which are part of stirrup-pore of the inner wall.

Discussion. According to Okulitch (1943, p. 60) the type of *Archaeocyathellus* is lost. The specimens I had opportunity to study from the type locality are poorly preserved and did not correspond to the description of holotype, having many rows of pores at the outer wall and sometimes porous septa; when preserved, the inner wall has stirrup-pores. Until further studies have been carried out we cannot be sure that *Stapicyathus* is sub-genus of *Archaeocyathellus*, as has been supposed. Meanwhile it will be considered as an independent genus. Its single row of pores relates it to *Robustocyathus*.

Systematic position. Family Robustocyathidae.

Stillicidocyathus Ting 1937

Type species by original designation: *Coscinocyathus aulax* Taylor (1910, p. 139). Holotype T 1605 B, University of Adelaide, South Australia.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (Ting 1937, p. 367). Körper kegelformig oder zylindrisch, grosswüchsig. Die Innenwand fehlt. Die Rinnenringe mit vollständigen Seitenwänden, aber modifiziert. Der Zapfenbesatz ist nach aussen verschoben und ihre Spitzen sind stark nach innen eingerkrümmt. Pseudo-septen zahlreich. Pseudoböden immer vorhanden und in weiten Abständen aufeinanderfolgend.

Present diagnosis. Gently wavy cone. Outer wall with regular alveoles. Inner wall annular, the section of which is S-shaped, strongly bent upward so that the apertures between adjacent septa are nearly closed up by two successive annuli. Septa radial with small remote pores. Scarce tabulae of normal type (Debrenne 1969b).

Discussion. Stillicidocyathus differs from *Salairocyathus* only by the shape of its annuli.

Systematic position. Family Stillicidocyathidae Ting 1937.

Syringocnema Taylor 1910

Type species, by original designation: *S. favus* Taylor (1910, p. 153, pl. XIV, fig. 78-79). Holotype No. T 1597, University of Adelaide.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (Taylor, p. 153). "A pipe-like cone with a diameter at the wider end of about 20 mm. It consists of an outer and inner wall—which are often papillate—between which extends a series of hexagonal tubes closely packed together, which radiate from the inner wall like the spokes of a wheel. The tubes have a diameter of about a millimetre and their axes are horizontal. The tube walls are perforated by fairly large pores which place them in communication with each other. The central cavity is narrow. . . ."

Present diagnosis. Unfortunately the type specimen is very badly preserved and the outer wall is missing; the diagnosis is based on the holotype and on paratypes T 1550, T 1558 which are of best preservation.

Conical cup, the intervallum of which consists of a packing of hexagonal porous tubes. The axes of the tubes are horizontal and radial from the outer wall for three-quarters of their length. Then they become narrower and bend downwards near the inner wall with a more or less acute angle. The outer wall is made of the apertures of hexagonal tubes, which are closed by rods rising from the angles and the middle part of skeletal boundaries. These rods bear spherical granules, which give the outer surface a regularly dotted appearance. The inner wall corresponds to the aperture of the narrow parts of the bending tubes. The pores are protected by denticular plates, rising from the lower edge of the pores: when in line, the plates join their neighbours and form an annular-like structure When in quincunx, the joining could be oblique or interrupted.

Systematic position. Family Syringocnematidae Taylor.

Thalamocyathus Gordon 1920

Type species by elimination by Ting 1937, p. 368: *Archaeocyathus trachealis* Taylor (1910, p. 125), lectotype Taylor 1910, pl. 8, fig. 47 (7-8) chosen by F. Debrenne (1969, p. 262) No. T 1555, University of Adelaide, South Australia.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (Ting 1937, p. 367-368). Körper kegelförmig oder zylindrisch, klein oder gross. Innenwand fehlt. Den Innenrändern der Pseudosepten sitzt ein System von Rinnenringen an. Die beiden Seitenränder der Rinnenringe sind gleich gut ausgebildet. Die Zapfen, die ihnen an der Mitte der Unterseite ansitzen, sind einfach und gerade. Die Pseudosepten sind zahlreich-Pseudoböden fehlen. Balkennetzwerk kann vorhanden sein oder fehlen. Die Gattung *Thalamocyathus* muss daher auf *Archaeocyathus trachealis* beschränkt bleiben.

Present diagnosis. Conical or cylindrical cups. The outer wall has simple pores, in regular quincunx, which could be narrowed outside. Inner wall annular, V-shaped with an obtuse angle. Radial septa with few or no pores. No pectinate tabulae (Debrenne 1969b).

Discussion. The lectotype has been chosen amongst Taylor's syntypes because of its better preservation, and because it agrees with the general conception of the genus. There are no pectinate tabulae amongst Taylor's syntypes. A very badly preserved specimen (pl. I-1) bears some siliceous granules which could be doubtfully regarded as a trace of tabulae. Consequently, *Gordonicyathus* Zhuravleva 1960 is a junior synonym of *Thalamocyathus*.

Systematic position. Family Cyclocyathellidae Zhuravleva 1959.

Zonacyathus Bedford and Bedford 1937

Type species by monotypy: *A. retevallum* Bedford and Bedford (1934, p. 2, fig. 6). Holotype: British Museum (Natural History) S 4147.

Lower Cambrian, Ajax Mine, Beltana, South Australia.

Original diagnosis (R. and J. Bedford 1937, p. 36). "Archaeocyathina with fine regularly arranged outer wall pores, closely set porous septa and an inner wall consisting of a reticular mesh of considerable thickness without a defined porous lamina. . . ."

Present diagnosis (Debrenne 1969a, p. 314). Porous two-walled cups with non-porous—or few porous—septa. The outer wall has regular pores. The inner wall has branching pore-tubes; the initial tube is located in the middle of each interseptum and then branches so that the secondary tubes open in front of each septa. The tubes may lengthen and curve into the central cavity.

Systematic position. ?family Ethmophyllidae Okulitch 1943.

APPENDIX

Notes on type species of new genera *Cricopectinus*, *Ethmopectinus* and *Rozanovicoscinus*.

Cricopectinus dentulus gen. sp. nov. Pl. I, fig. 1.

1919—*Ethmophyllum dentatum* Taylor (pro parte): p. 129, pl. XIV, fig. 89.

Holotype: University of Adelaide T 1589 B.

Type-locality: Ajax Mine, Beltana, South Australia.

Age: Lower Cambrian.

Description: as for the genus.

Dimensions:

Cup

Height (pars)	23·5 mm.
Diameter	10·5 mm.
Intervallum	1·62 mm.
Interseptum	0·16 mm.

Outer wall	
Number of pores per interseptum	2
Diameter of pores	0·95 mm.
Skeletal partition	0·05 mm.
Thickness	0·08 mm.
Inner wall	
Number of pores per interseptum	1
Diameter of pores	0·16 mm.
Skeletal partition	0·32 mm.
Thickness	0·8 mm.
Septa	
Non-porous except	
1 vertical row of pores near the outer wall.	
Thickness	0·08 mm.

Discussion. Only one specimen known. It differs from *Cyathocricus dentatus* by the presence of pectinate tabulae.

Ethmopectinus walteri gen. sp. nov. Pl. I, fig. 2.
Holotype: 86762 Princeton University.
Paratype: 86755 Princeton University.
Type-locality: Ajax Mine, Beltana, South Australia.
Age: Lower Cambrian.
Description: as for genus.

Dimensions:

	Holotype	Paratype
Cup		
Height (pars)	9 mm.	11 mm.
Diameter	8 mm.	12 mm.
Intervallum	1·8 mm.	2 mm.
Interseptum	0·21 mm.	0·16 mm.
Intertabulum	unknown (1 tabula)	5·7 mm.
Parietal coefficient	9	unknown
Outer wall		
No. of pores per interseptum	3-4	3
Diameter of pores	0·03-0·05 mm.	0·03-0·05 mm.
Skeletal partition	0·03 mm.	0·03 mm.
Thickness	0·05 mm.	0·05 mm.
Inner wall		
No. of pores per interseptum	1	1
Diameter	0·16 mm.	0·21 mm.
No. of horizontal lamellae per pore	3	5
Distance between lamellae	0·05 mm.	0·03 mm.
Thickness of lamellae	0·05 mm.	0·03 mm.
Septa		
Non-porous except 4 rows of pores near the outer wall		non-porous
Diameter of pores	0·03 mm.	
Thickness	0·05 mm.	0·05 mm.

Discussion. Only two specimens known. They differ from *lineatus* by the presence of pectinate tabulae. This species is dedicated to Dr. M. R. Walter, University of Adelaide.

Rozanovicoscinus fonini gen. sp. nov. Pl. II, fig. 1.
Holotype: Princeton University 86614.
Type-locality: Ajax Mine, Beltana, South Australia.
Age: Lower Cambrian.
Description: as for the genus.

Dimensions.

Cup		
Cup		
Height (pars)	60	mm.
Diameter	14·5	mm.
Intervallum		
along a septa	2·75	mm.
at the middle of furrow	3·15	mm.
Interseptum	1	mm.
Intertabulum	2-3	mm.
Parietal coefficient	2·4	
Outer wall		
No. of pores per interseptum	6-8	
Diameter	0·1	mm.
Skeletal partition	0·09-0·1	mm.
Thickness	1	mm.
Inner wall		
No. of pores per interseptum	2-3	
Diameter of pores	0·2	mm.
Skeletal partition	0·1	mm.
Thickness	0·20	mm.
Septa		
No. of pores per intervallum	8-10	
Diameter of pores	0·09	mm.
Skeletal partition	0·16	mm.
Thickness	0·1	mm.
Tabulae		
No. of pores per interseptum	5-8	
Diameter of pores	0·06	mm.
Skeletal partition	0·06	mm.
Thickness	0·1	mm.

Discussion. Placed by R. and J. Bedford with paratypes of *Cadniacyathus asperatus* because of vertical fluting of outer wall; the specimen described above differs from it by the presence of tabulae and the simplest porosity of inner wall. This species is dedicated to V. D. Fonin (Paleontological Institute, Academy of Science of the U.S.S.R., Moscow).

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